Amendments to the Specification:

Please replace the paragraphs numbered [0009], [0010], [0032], [0033], [0036], [0039], [0042], [0045], [0046], [0047], [0048], [0052], [0053] and [0058] as follows:

[0009] **FIG. 7** illustrates a top view of a second embodiment of a multi-beam antenna, comprising a plurality of electromagnetic lenses located proximate to one edge of a dielectric substrate;

[0010] **FIG. 8** illustrates a top view of a third embodiment of a multi-beam antenna, comprising a plurality of electromagnetic lenses located proximate to opposite edges of a dielectric substrate;

[0032] The at least one **electromagnetic lens 12** has a **first side 22** having a **first contour 24** at an intersection of the **first side 22** with a **reference surface 26**, for example, a **plane 26.1**. The at least one **electromagnetic lens 12** acts to diffract the electromagnetic wave from the respective **antenna feed elements 14**, wherein different **antenna feed elements 14** at different locations and in different directions relative to the at least one **electromagnetic lens 12** generate different associated **beams of electromagnetic energy 20**. The at least one **electromagnetic lens 12** has a **refractive index n** different from free space, for example, a **refractive index n** greater than one (1). For example, the at least one **electromagnetic lens 12** may be constructed of a material such as REXOLITE™, TEFLON™, polyethylene, or polystyrene; or a plurality of different materials having different refractive indices, for example as in a Luneburg lens. In accordance with known principles of diffraction, the shape and size of the at least one **electromagnetic lens 12**, the **refractive index n** thereof, and the relative position of the **antenna feed elements 14** to the **electromagnetic lens 12** are adapted in accordance with the radiation patterns of the **antenna feed elements 14** to provide a desired pattern of radiation of the respective **beams of electromagnetic energy 20** exiting the **second side 28** of the at least one **electromagnetic lens 12**. Whereas the at least one **electromagnetic lens 12** is illustrated as a **spherical lens 12**[[“]]' in **Figs. 1** and **2**, the at least one **electromagnetic lens 12** is not limited to any one particular design, and may, for example, comprise either a spherical lens, a Luneburg lens, a spherical shell lens, a hemispherical lens, an at least partially spherical lens, an at least partially spherical shell lens, a cylindrical lens, or a rotational lens. Moreover, one or more portions of the **electromagnetic lens 12** may be truncated for improved packaging, without

significantly impacting the performance of the associated **multi-beam antenna 10, 10.1**. For example, **Fig. 3** illustrates an at least partially spherical **electromagnetic lens 12[[""]]''** with opposing **first 27** and **second 29 portions** removed therefrom.

[0033] The **first edge 18** of the **dielectric substrate 16** comprises a **second contour 30** that is proximate to the **first contour 24**. The **first edge 18** of the **dielectric substrate 16** is located on the **reference surface 26**, and is positioned proximate to the **first side 22** of one of the at least one **electromagnetic lens 12**. The **dielectric substrate 16** is located relative to the **electromagnetic lens 12** so as to provide for the diffraction by the at least one **electromagnetic lens 12** necessary to form the **beams of electromagnetic energy 20**. For the example of a **multi-beam antenna 10** comprising a planar **dielectric substrate 16** located on **reference surface 26** comprising a **plane 26.1**, in combination with an **electromagnetic lens 12** having a **center 32**, for example, a **spherical lens 12[["]]'**; the **plane 26.1** may be located substantially close to the **center 32** of the **electromagnetic lens 12** so as to provide for diffraction by at least a portion of the **electromagnetic lens 12**. Referring to **Fig. 4**, the **dielectric substrate 16** may also be displaced relative to the **center 32** of the **electromagnetic lens 12**, for example on one or the other side of the **center 32** as illustrated by **dielectric substrates 16[["]]'** and **16[[""]]''**, which are located on respective **reference surfaces 26[["]]'** and **26[[""]]''**.

[0036] Referring to **Fig. 4**, the **direction 42** of the one or more **beams of electromagnetic energy 20** through the **electromagnetic lens 12, 12[["]]'** is responsive to the relative location of the **dielectric substrate 16, 16[["]]'** or **16[[""]]''** and the associated **reference surface 26, 26[["]]'** or **26[[""]]''** relative to the **center 32** of the **electromagnetic lens 12**. For example, with the **dielectric substrate 16** substantially aligned with the **center 32**, the **directions 42** of the one or more **beams of electromagnetic energy 20** are nominally aligned with the **reference surface 26**. Alternately, with the **dielectric substrate 16[["]]'** above the **center 32** of the **electromagnetic lens 12, 12[["]]'**, the resulting one or more **beams of electromagnetic energy 20[["]]'** propagate in **directions 42[["]]'** below the **center 32**. Similarly, with the **dielectric substrate 16[[""]]''** below the **center 32** of the **electromagnetic lens 12, 12[["]]'**, the resulting one or more **beams of electromagnetic energy 20[[""]]''** propagate in **directions 42[[""]]''** above the **center 32**.

[0039] In operation, a **feed signal 58** applied to the **corporate antenna feed port 54** is either blocked -- for example, by an open circuit, by reflection or by absorption, -- or switched to the associated **feed port 46** of one or more **antenna feed elements 14**, via one or more associated **transmission lines 44**, by the **switching network 48**, responsive to a **control signal 60** applied to the **control port 56**. It should be understood that the **feed signal 58** may either comprise a single signal common to each **antenna feed element 14**, or a plurality of signals associated with different **antenna feed elements 14**. Each **antenna feed element 14** to which the **feed signal 58** is applied launches an associated electromagnetic wave into the **first side 22** of the associated **electromagnetic lens 12**, which is diffracted thereby to form an associated **beam of electromagnetic energy 20**. The associated **beams of electromagnetic energy 20** launched by different **antenna feed elements 14** propagate in different associated **directions 42**. The various **beams of electromagnetic energy 20** may be generated individually at different times so as to provide~~d~~ for a scanned **beam of electromagnetic energy 20**. Alternately, two or more **beams of electromagnetic energy 20** may be generated simultaneously. Moreover, different **antenna feed elements 14** may be driven by different frequencies that, for example, are either directly switched to the respective **antenna feed elements 14**, or switched via an associated **switching network 48** having a plurality of **inputs 50**, at least some of which are each connected to different **feed signals 58**.

[0042] Referring to **Figs. 7, 8** and **9**, in accordance with a second aspect, a **multi-beam antenna 10[[“]]’** comprises at least a **first 12.1** and a **second 12.2 electromagnetic lens**, each having a **first side 22.1, 22.2** with a corresponding **first contour 24.1, 24.2** at an intersection of the respective **first side 22.1, 22.2** with the **reference surface 26**. The **dielectric substrate 16** comprises at least a **second edge 62** comprising a **third contour 64**, wherein the **second contour 30** is proximate to the **first contour 24.1** of the **first electromagnetic lens 12.1** and the **third contour 64** is proximate to the **first contour 24.2** of the **second electromagnetic lens 12.2**.

[0045] Referring to **Fig. 9**, in accordance with a third aspect, a **multi-beam antenna 10[[“““]]’’** comprises at least one **reflector 66,** wherein the **reference surface 26** intersects the at least one **reflector 66** and one of the at least one **electromagnetic lens 12** is located between the **dielectric substrate 16** and the **reflector 66**. The at least one **reflector 66** is adapted to reflect electromagnetic energy propagated through the at least one **electromagnetic lens 12** after being generated by at least one of the plurality of **antenna**

feed elements 14. A third embodiment of the **multi-beam antenna 10** comprises at least **first 66.1** and **second 66.2 reflectors** wherein the **first electromagnetic lens 12.1** is located between the **dielectric substrate 16** and the **first reflector 66.1**, the **second electromagnetic lens 12.2** is located between the **dielectric substrate 16** and the **second reflector 66.2**, the **first reflector 66.1** is adapted to reflect electromagnetic energy propagated through the **first electromagnetic lens 12.1** after being generated by at least one of the plurality of **antenna feed elements 14** on the **second contour 30**, and the **second reflector 66.2** is adapted to reflect electromagnetic energy propagated through the **second electromagnetic lens 12.2** after being generated by at least one of the plurality of **antenna feed elements 14** on the **third contour 64**. For example, the **first 66.1** and **second 66.2 reflectors** may be oriented to direct the **beams of electromagnetic energy 20** from each side in a common nominal direction, as illustrated in **Fig. 9**. Referring to **Fig. 9**, the **multi-beam antenna 10[[“““]]’’** as illustrated would provide for scanning in a direction normal to the plane of the illustration. If the **dielectric substrate 16** were rotated by **90** degrees with respect to the **reflectors 66.1, 66.2,** about an axis connecting the respective **electromagnetic lenses 12.1, 12.1**, then the **multi-beam antenna 10[[“““]]’’** would provide for scanning in a direction parallel to the plane of the illustration.

[0046] Referring to **Fig. 10**, in accordance with the third aspect and a fourth embodiment, a **multi-beam antenna 10[[“““]]’’, 10.4** comprises an at least partially spherical **electromagnetic lens 12[[““““]]’’’**, for example, a hemispherical electromagnetic lens, having a **curved surface 68** and a **boundary 70**, for example a **flat boundary 70.1**. The **multi-beam antenna 10[[“““]]’’, 10.4** further comprises a **reflector 66** proximate to the **boundary 70**, and a plurality of **antenna feed elements 14** on a **dielectric substrate 16** proximate to a **contoured edge 72** thereof, wherein each of the **antenna feed elements 14** is adapted to radiate a respective plurality of **beams of electromagnetic energy 20** into a **first sector 74** of the **electromagnetic lens 12[[““““]]’’’**. The **electromagnetic lens 12[[““““]]’’’** has a **first contour 24** at an intersection of the **first sector 74** with a **reference surface 26**, for example, a **plane 26.1**. The **contoured edge 72** has a **second contour 30** located on the **reference surface 26** that is proximate to the **first contour 24** of the **first sector 74**. The **multi-beam antenna 10[[“““]]’’, 10.4** further comprises a **switching network 48** and a plurality of **transmission lines 44** operatively connected to the **antenna feed elements 14** as described hereinabove for the other embodiments.

[0047] In operation, at least one **feed signal 58** applied to a **corporate antenna feed port 54** is either blocked, or switched to the associated **feed port 46** of one or more **antenna feed elements 14**, via one or more associated **transmission lines 44**, by the **switching network 48** responsive to a **control signal 60** applied to a **control port 56** of the **switching network 48**. Each **antenna feed element 14** to which the **feed signal 58** is applied launches an associated electromagnetic wave into the **first sector 74** of the associated **electromagnetic lens 12[[“““]]’’’**. The electromagnetic wave propagates through -- and is diffracted by -- the **curved surface 68**, and is then reflected by the **reflector 66** proximate to the **boundary 70**, whereafter the reflected electromagnetic wave propagates through the **electromagnetic lens 12[[“““]]’’’** and exits -- and is diffracted by -- a **second sector 76** as an associated **beam of electromagnetic energy 20**. With the **reflector 66** substantially normal to the **reference surface 26** -- as illustrated in **Fig. 10** -- the different **beams of electromagnetic energy 20** are directed by the associated **antenna feed elements 14** in different directions that are nominally substantially parallel to the **reference surface 26**.

[0048] Referring to **Fig. 11**, in accordance with a fourth aspect and a fifth embodiment, a **multi-beam antenna 10[[“““]]’’’, 10.5** comprises an **electromagnetic lens 12** and plurality of **dielectric substrates 16**, each comprising a set of **antenna feed elements 14** and operating in accordance with the description hereinabove. Each set of **antenna feed elements 14** generates (or is capable of generating) an associated set of **beams of electromagnetic energy 20.1, 20.2** and **20.3**, each having associated **directions 42.1, 42.2** and **42.3**, responsive to the associated **feed 58** and **control 60 signals**. The associated **feed 58** and **control 60 signals** are either directly applied to the associated **switch network 48** of the respective sets of **antenna feed elements 14**, or are applied thereto through a **second switch network 78** ~~have~~ having associated **feed 80** and **control 82 ports**, each comprising at least one associated signal. Accordingly, the **multi-beam antenna 10[[“““]]’’’, 10.4** provides for transmitting or receiving one or more beams of electromagnetic energy over a three-dimensional space.

[0052] The **frequency selective surface 114** can be constructed by forming a periodic structure of conductive elements, e.g. by etching a conductive sheet on a substrate material having a relatively low dielectric constant, e.g. DUROID™ or TEFLON™. For example, referring to **Fig. 13**, the **frequency selective surface 114** is formed by a field of what are known as **Jerusalem Crosses 116**, which provides for reflectivity and transmissivity

characteristics illustrated in **Figs. 14** and **15** respectively, wherein the **frequency selective surface 114** is sized so as to substantially transmit a first electromagnetic wave having an associated **first carrier frequency f_1** of 77 GHz, and to substantially reflect a second electromagnetic wave having an associated **first carrier frequency f_1** of **24** GHz. In **Figs. 14** and **15**, "O" and "P" represent orthogonal and parallel polarizations respectively. Each **Jerusalem Cross 116** is separated from a surrounding **conductive surface 118** by a **slot 120** that is etched thereinto, wherein the **slot 120** has an associated **slot width ws**. Each **Jerusalem Cross 116** comprises four **legs 122** of **leg length L** and **leg width wm** extending from a central square hub and forming a cross. Adjacent **Jerusalem Crosses 116** are separated from one another by the associated **slots 120**, and by conductive **gaps G**, so as to form a periodic structure with a **periodicity DX** in both associated directions of the **Jerusalem Crosses 116**. The exemplary embodiment illustrated in **Fig. 13** having a pass frequency of 77 GHz is characterized as follows: **slot width ws** = **80** microns, **leg width wm** = **200** microns, **gap G** = **150** microns, **leg length L** = **500** microns, and **periodicity DX** = **1510** microns (in both orthogonal directions), where **DX=wm+ 2(L+ws)+G**. Generally the **frequency selective surface 114** comprises a periodic structure of conductive elements, for example, located on a dielectric substrate, for example, substantially located on a plane. The conductive elements need not necessarily be located on a substrate. For example, the **frequency selective surface 114** could be constructed from a conductive material with periodic holes or openings of appropriate size, shape and spacing. Alternately, the **frequency selective surface 114** may comprise a conductive layer on one or both inner surfaces of the respective **first 108** and **second 110 portions** of the **electromagnetic lens 102**. Whereas **Fig. 13** illustrates a **Jerusalem Cross 116** as a kernel element of the associate periodic structure of the **frequency selective surface 114**, other shapes for the kernel element are also possible, for example circular, doughnut, rectangular, square, or potent cross, for example, as illustrated in the following technical papers that are incorporated herein by reference: "Antenna Design on Periodic and Aperiodic Structures" by Zhifang Li, John L. Volakis and Panos Y. Papalambros accessible at Internet address http://ode.engin.umich.edu/papers/APS2000.pdf; and "Plane Wave Diffraction by Two-Dimensional Gratings of Inductive and Capacitive Coupling Elements" by Yu. N. Kazantsev, V.P. Mal[["]]'tsev, E.S. Sokolovskaya, and A.D. Shatrov in "Journal of Radioelectronics" N. 9, 2000 accessible at Internet address http://jre.cplire.ru/jre/sep00/4/text.html.

[0053] Experiments have also shown that in a system with **first f_1** and **second f_2 carrier frequencies** selected from **24** GHz and **77** GHz, an electromagnetic wave having a **24** GHz carrier frequency generates harmonic modes when passed through the **frequency selective surface 114** illustrated in **Fig. 13**. Accordingly, ~~the~~ a **first carrier frequency f_1** (of the transmitted electromagnetic wave) greater than the **second carrier frequency f_2** (of the reflected electromagnetic wave) would beneficially provide for reduced harmonic modes. However, it is possible to have a wider field of view in the transmitted electromagnetic wave than in the reflected electromagnetic wave. More particularly, the beam patterns from a reflected feed source are, for example, only well behaved over a range of approximately +/- 20°, which would limit the field of view to approximately 40°. In some applications, e.g. automotive radar, it is beneficial for the lower frequency electromagnetic wave to have a wider field of view. Accordingly, it can be beneficial for the **first carrier frequency f_1** (of the transmitted electromagnetic wave) to have the lower frequency (e.g. **24** GHz), which can be facilitated with a multiple layer **frequency selective surface 114**.

[0058] Referring to **Fig. 17**, in accordance with an eighth embodiment of a multi-beam antenna **132** incorporating a **polarization selective element 130**, a **polarization rotator 134** is incorporated between the **first antenna feed element 104, 14** and the ~~**electromagnetic lens 102**~~ **first portion 108** of the **electromagnetic lens 102**, for example, so that the **first 104** and second **106 antenna feed elements 14** can be constructed on a common substrate. Alternately, instead of incorporating a separate **polarization rotator 134**, the **first portion 108** of the **electromagnetic lens 102** may be adapted to incorporate~~d~~ an associated polarization rotator.